

## **Patent Claims**

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  1. Electro-optical light modulation element comprising
    - a substrate or a plurality of substrates,
    - an electrode arrangement,
    - at least one element or a plurality of elements for polarisation of the light and
    - a modulation medium,  
characterised in that
    - the light modulation element is operated at a temperature at which the modulation medium is in an optically isotropic phase in the unaddressed state, and in that
    - the electrode arrangement can generate an electric field having a significant component parallel to the surface of the mesogenic modulation medium, and in that
    - the mesogenic modulation medium satisfies at least one of the following following conditions (a) and (f) and, in the case where it only satisfies condition (a) of these two conditions (a) and (f), it additionally satisfies at least one of the following conditions (b) and (c) and, in the case where it only satisfies condition (c) of conditions (b) and (c), it satisfies at least one of the two further following conditions (d) and (e), and, in the case where it satisfies condition (f), it optionally additionally satisfies condition (g),
      - (a) the modulation medium has, with increasing temperature, a transition from the nematic phase or from the cholesteric phase into the isotropic phase ( $T(N,I)$  or  $T(N^*,I)$ ), and the dielectric susceptibility of the modulation medium at a temperature of 4 degrees above the clearing point is 25 or more,
      - (b) the enthalpy of clearing of the modulation medium is 0.78 J/g or less, or
      - (c) the enthalpy of clearing of the modulation medium is 1.50 J/g or less, and
      - (d) the dielectric susceptibility of the modulation medium at a temperature of 4 degrees above the clearing point is 25 or more,

clearing point is 27 or more, with the proviso that light modulation elements containing modulation media which comprise 8%, 10% or 12% of compound UVZG-3-N are excluded, or

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(e) the dielectric susceptibility of the modulation medium at a temperature of 4 degrees above the clearing point is 35.5 or more, with the proviso that light modulation elements containing modulation media having one of the two following compositions 1 and 2

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Composition 1			Composition 2		
Compound #	Abbreviation	Conc. / %	Compound #	Abbreviation	Conc. / %
1	UZU-3A-N	12.0	1	UM-3-N	10.0
2	UZU-5A-N	12.0	2	PYP-3N.F.F	15.0
3	GZU-3A-N	12.0	3	UZU-3A-N	12.0
4	GZU-4A-N	11.0	4	GZU-3A-N	12.0
5	GZU-4O-N	10.0	5	GZU-4-N	1.0
6	UVZG-3-N	10.0	6	GZU-4O-N	10.0
7	CUZU-2-N	10.0	7	UVZG-3-N	10.0
8	CUZU-3-N	10.0	8	CUZU-2-N	10.0
9	CUZU-4-N	10.0	9	CUZU-3-N	10.0
10	HP-5N.F	3.0	10	HP-3N.F	10.0

are excluded, where the abbreviations for the compounds are as defined in the application text,

- (g) the modulation medium has, with increasing temperature, a transition from the cholesteric phase (Ch, here referred to as the chiral nematic phase N\*) into a blue phase (BP) at a temperature  $T(N^*,BP)$ , and
- (h) the dielectric susceptibility of the modulation medium at a temperature of 4 degrees above this transition temperature ( $T(N^*,BP)$ ) is 25 or more.

2. Light modulation element according to Claim 1, characterised in that
  - the enthalpy of clearing of the mesogenic modulation medium is 1.10 J/g or less.

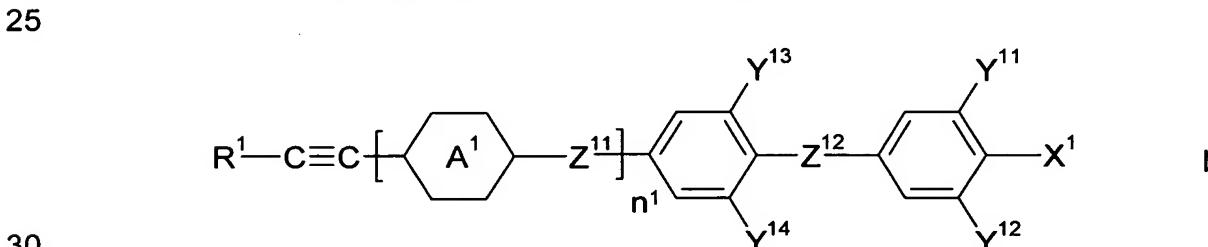
3. Light modulation element according to Claim 2, characterised in that
- the enthalpy of clearing of the mesogenic modulation medium is 0.70 J/g or less.

- 5 4. Light modulation element according to at least one of Claims 1 to 3, characterised in that
- the dielectric susceptibility of the modulation medium at a temperature of 4 degrees above the clearing point or transition temperature ( $T(N^*,BP)$ ) is 40 or more.

- 10 5. Light modulation element according to Claim 4, characterised in that
- the dielectric susceptibility of the modulation medium at a temperature of 4 degrees above the clearing point or transition temperature ( $T(N^*,BP)$ ) is 55 or more.

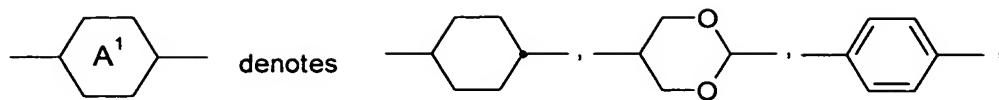
- 15 6. Light modulation element according to at least one of Claims 1 to 5, characterised in that
- the optical anisotropy at a temperature of 4 degrees below the clearing point or transition temperature ( $T(N^*,BP)$ ) is 0.080 or more.

- 20 7. Light modulation element according to at least one of Claims 1 to 6, characterised in that the mesogenic modulation medium comprises one or more compounds of the formula I

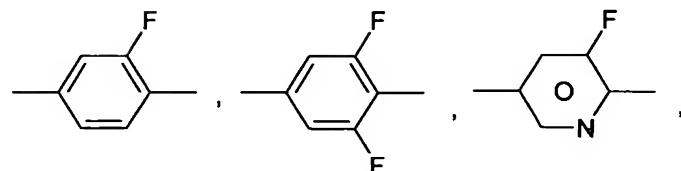


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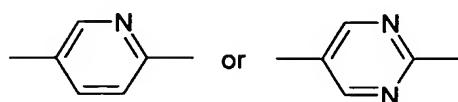
35  $R^1$  denotes alkyl having 1 to 7 C atoms or oxaalkyl having 2 to 7 C atoms,



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$Z^{11}$  and  $Z^{12}$  each, independently of one another, denote a single bond, -CO-O-, trans -CH=CH-, -CH=CF-, -CF=CH-,  
 $-CF=CF-$ , -CH=CH-CO-O-, -CF=CF-CO-O-, -CF=CH-CO-O-, -CH=CF-CO-O-, -CF<sub>2</sub>-O-, -O-CF<sub>2</sub>- or -C≡C- or a combination of two or more of these groups,

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$X^1$  denotes F, Cl, NO<sub>2</sub>, -OCF<sub>3</sub>, -CF<sub>3</sub>, -OCF<sub>2</sub>H, Cl, CN, -C≡C-CN or NCS,

$Y^{11}$ ,  $Y^{12}$ ,  $Y^{13}$  and  $Y^{14}$  each, independently of one another, denote H or F and

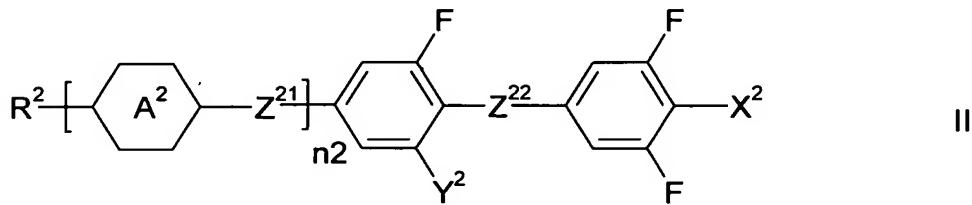
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$n^1$  denotes 0 or 1.

8. Light modulation element according to at least one of Claims 1 to 7, characterised in that the mesogenic modulation medium comprises one or more compounds of the formula II

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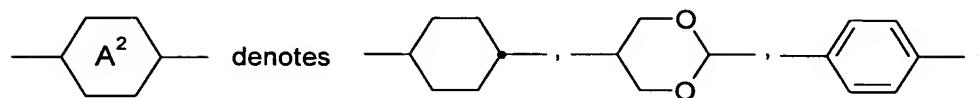
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in which

$R^2$  denotes alkyl or alkoxy having 1 to 7 C atoms, alkenyl, alkenyloxy or oxaalkyl having 2 to 7 C atoms,

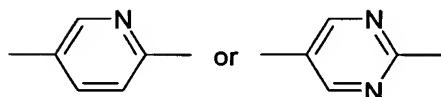
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$Z^{21}$  and  $Z^{22}$  each, independently of one another, denote a single bond, -CO-O-, trans -CH=CH-, -CH=CF-, -CF=CH-, -CF=CF-, -CH=CF-CO-O-, -CF<sub>2</sub>-O-, -O-CF<sub>2</sub>- or -C≡C- or a combination of two or more of these groups,

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$X^2$  denotes F, Cl, NO<sub>2</sub>, -OCF<sub>3</sub>, -CF<sub>3</sub>, -OCF<sub>2</sub>H, Cl, CN, -C≡C-CN or NCS,

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$Y^2$  denotes H or F, and

$n^2$  denotes 0 or 1.

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9. Light modulation element according to at least one of Claims 1 to 8, characterised in that the medium, besides the compounds of the formulae I and/or II, comprises one or more further mesogenic compounds.

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10. Light modulation element according to at least one of Claims 1 to 9, characterised in that the mesogenic modulation medium comprises  
- 5% to 80 of one or more compounds of the formula I and/or

- 5% to 95% of one or more compounds of the formula II and/or
  - 0% to 30% of one or more further mesogenic compounds.
- 5        11. Electro-optical display containing one or more light modulation elements according to at least one of Claims 1 to 10.
- 10      12. Electro-optical display according to Claim 11, characterised in that the display is addressed by means of an active matrix.
- 15      13. Electro-optical display system containing one or more electro-optical displays according to at least one of Claims 11 and 12.
- 20      14. Electro-optical display system according to Claim 13, characterised in that it can be used as a television screen, as a computer monitor or as both.
- 25      15. Use of a light modulation element according to at least one of Claims 1 to 10 for the display of information.
- 30      16. Use of an electro-optical display according to at least one of Claims 11 and 12 in an electro-optical display system.
- 35      17. Use of an electro-optical display system according to at least one of Claims 13 and 14 for the display of video signals or digital signals.
18. Medium, characterised in that it satisfies the following condition (a) and at least one of the two further following conditions (b) and (c)
  - (a) the medium has, with increasing temperature, a transition from the nematic phase or from the cholesteric phase into the isotropic phase ( $T(N,I)$  or  $T(N^*,I)$ ), and the enthalpy of clearing of the medium is 1.50 J/g or less, and
  - (b) the dielectric susceptibility of the medium at a temperature of 4 degrees above the clearing point is 27 or more, with the proviso that media which comprise 8%, 10% or 12% of compound UVZG-3-N are excluded, or

- (c) the dielectric susceptibility of the medium at a temperature of 4 degrees above the clearing point is 35.5 or more, with the proviso that media having one of the two following compositions 1 and 2

	Composition 1			Composition 2		
	Compound #	Abbreviation	Conc. / %	Compound #	Abbreviation	Conc. / %
5	1	UZU-3A-N	12.0	1	UM-3-N	10.0
10	2	UZU-5A-N	12.0	2	PYP-3N.F.F	15.0
15	3	GZU-3A-N	12.0	3	UZU-3A-N	12.0
20	4	GZU-4A-N	11.0	4	GZU-3A-N	12.0
25	5	GZU-4O-N	10.0	5	GZU-4-N	1.0
30	6	UVZG-3-N	10.0	6	GZU-4O-N	10.0
35	7	CUZU-2-N	10.0	7	UVZG-3-N	10.0
	8	CUZU-3-N	10.0	8	CUZU-2-N	10.0
	9	CUZU-4-N	10.0	9	CUZU-3-N	10.0
	10	HP-5N.F	3.0	10	HP-3N.F	10.0

are excluded, where the abbreviations for the compounds are as defined in the application text,

or in that the medium satisfies condition (d)

- (d) the modulation medium has, with increasing temperature, a transition from the cholesteric phase into a blue phase (BP) at a temperature  $T(N^*, BP)$ , and in that optionally the dielectric susceptibility of the modulation medium at a temperature of 4 degrees above this transition temperature is 25 or more.

19. Medium according to Claim 18, characterised in that it has an enthalpy of clearing of 1.00 J/g or less.
20. Medium according to Claim 19, characterised in that it has an enthalpy of clearing of 0.80 J/g or less.
21. Medium according to at least one of Claims 18 to 20, characterised in that the dielectric susceptibility of the medium at a temperature of 4

degrees above the clearing point or conversion temperature is 40 or more.

- 5        22. Medium according to Claim 21, characterised in that the dielectric susceptibility of the medium at a temperature of 4 degrees above the clearing point or conversion temperature is 55 or more.
- 10      23. Medium according to at least one of Claims 18 to 22, characterised in that it has a clearing point or conversion temperature in the range from -30°C to 80°C.
- 15      24. Medium according to Claim 23, characterised in that it has a clearing point or conversion temperature in the range from 0°C to 45°C.
- 20      25. Medium according to at least one of Claims 18 to 24, characterised in that the optical anisotropy of the medium at a temperature of 4 degrees below the clearing point or conversion temperature is 0.080 or more.
- 25      26. Medium according to at least one of Claims 18 to 25, characterised in that it comprises one or more compounds of the formula I as indicated in Claim 7.
- 30      27. Medium according to at least one of Claims 18 to 26, characterised in that it comprises one or more compounds of the formula II as indicated in Claim 7.
- 35      28. Medium according to at least one of Claims 18 to 27, characterised in that, besides the compounds of the formulae I and/or II, it comprises one or more further mesogenic compounds.
29. Medium according to at least one of Claims 18 to 28, characterised in that the medium comprises
  - 5% to 80% of one or more compounds of the formula I and/or
  - 5% to 95% of one or more compounds of the formula II and/or
  - 0% to 30% of one or more further mesogenic compounds.